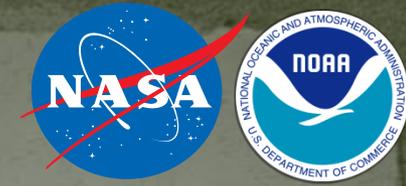




Improved Observations of Earth and Space Weather From GOES-R

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Presentation Outline

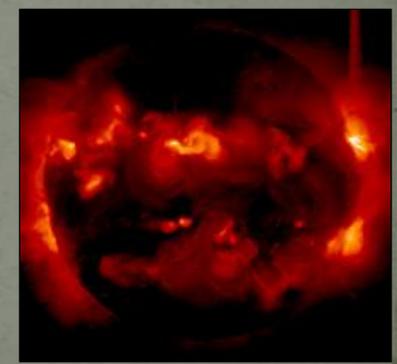
- Program Overview
- GOES-R Improvements
- Ground Segment Organization
- Ground Segment Architecture
- Product Generation



GOES Satellite Mission



- Weather sentinel
 - **Hurricanes**
 - **Severe storms**
 - **Flash floods**
- Input to weather models, forecasts and warnings
- Fire and smoke products for air quality monitoring and forecasting and fire fighting
- Sea surface temperature monitoring for fisheries and climate
- Winds for aviation
- Solar imagery for communication satellites, utility companies, and astronaut safety
- Environmental data collection—buoys, rain gauges...
- Search and Rescue
- GOES data shared within the western hemisphere





GOES Launch Schedule



- GOES R series is a follow-on to the existing line of NOAA's geostationary weather satellites.

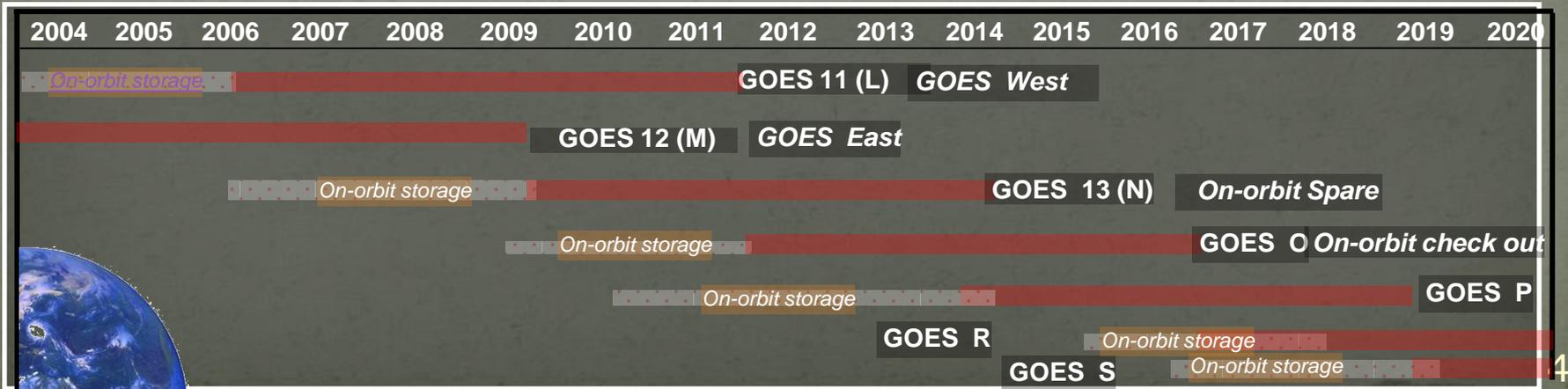
GOES-1 launched in 1975

GOES I series [8-12]: Operational since 1994

GOES N series [13]: N launched May 24 2006,

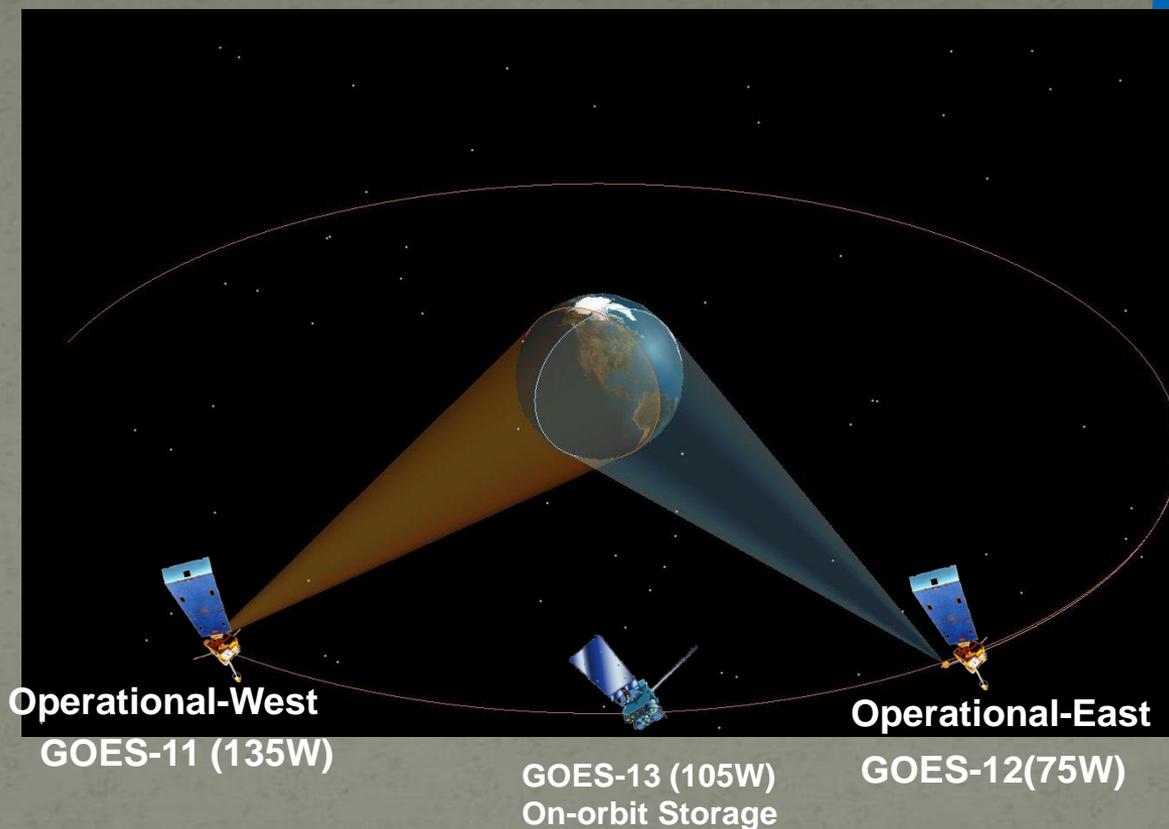
O launched 26th June 2009, P planned launch 2010

Based on an availability analysis of the current GOES I and N-series, a GOES-R launch is required in the 2015 timeframe to maintain mission data continuity



Note: Satellites are labeled with letters on the ground and changed to numbers on-orbit

Current GOES Constellation



- GOES mission requires two on-orbit operational satellites and one on-orbit spare
- **GOES-West location in GOES-R series to be 137°W instead of current 135°W**
 - Eliminates conflicts with other satellite systems in X-band frequency at 135°W

* Note: Satellites are labeled with letters on the ground and changed to numbers on-orbit



GOES-R Measurement Objectives



Purpose	Sensor
<ul style="list-style-type: none">• Provide environmental data to produce routine meteorological analyses and forecasts; mesoscale and synoptic scale storm prediction.	Advanced Baseline Imager
<ul style="list-style-type: none">• Provide continuous full-disk lightning measurements for storm warning and nowcasting.	Geostationary Lightning Mapper (GLM)
<ul style="list-style-type: none">• Imaging of the solar EUV emissions• Locate coronal holes for forecasts of recurring geomagnetic activity• Locate flares for forecasts of solar energetic particle events	Solar Ultra Violet Imager (SUVI)
<ul style="list-style-type: none">• Measure the magnitude of solar X-ray and EUV irradiance	Extreme Ultra Violet Sensor/X-Ray Sensor Irradiance Sensor (EXIS)
<ul style="list-style-type: none">• Measurements of the electron, proton, and heavy ion fluxes	Space Environmental In-Situ Suite (SEISS)
<ul style="list-style-type: none">• Magnetic field measurements to detect space plasma storms and substorms	Magnetometer



GOES-R Improvements in Earth Observations



Performance Capability	GOES N-P	GOES R
Earth Imaging		
Visible Resolution	1 km	0.5 km
IR Resolution	4-8 km N 4 km O/P	1-2 km
Full Disk Coverage Rate	30 min	5 min
# of Channels	5	16
Raw Data Volume from Imager	2.6 Mbps	66 Mbps
Geostationary Lightning Mapper	N/A	Lightning Events, Groups and Flashes

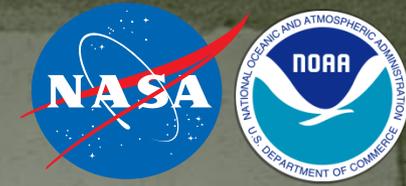
- **GOES-R provides significant increases in spatial, spectral, and temporal resolution of products**



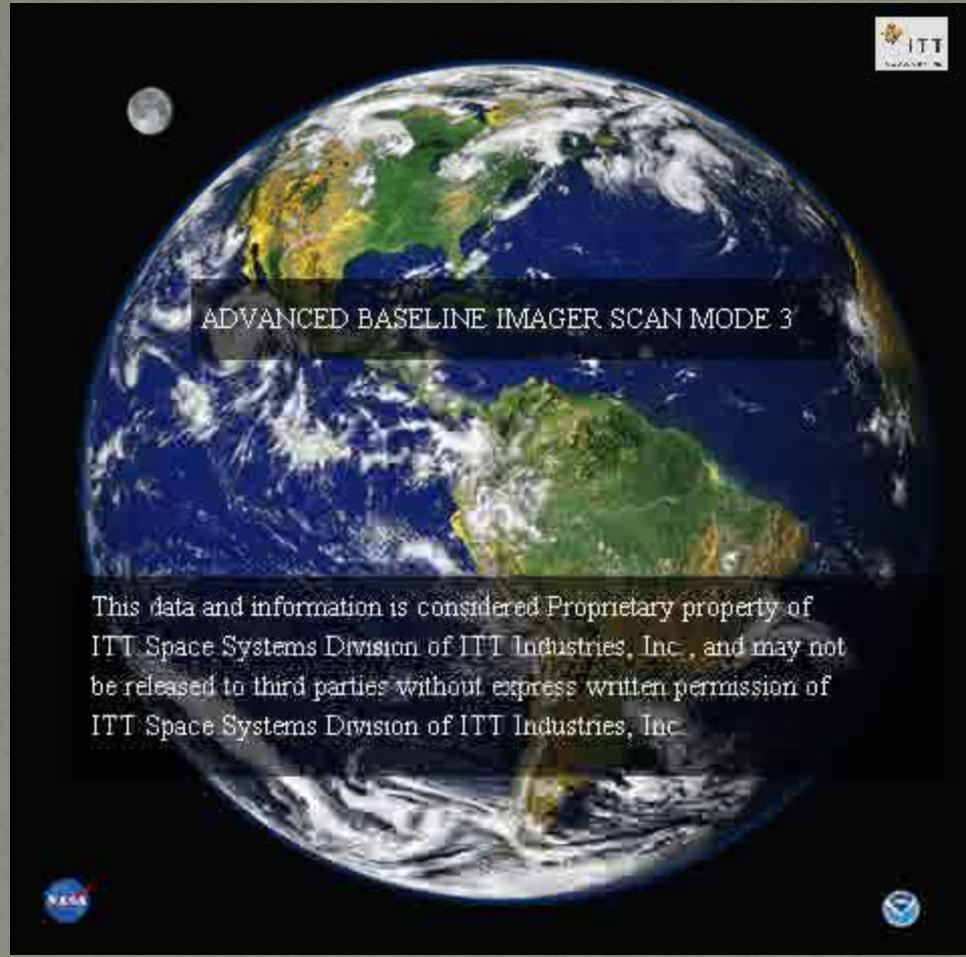
GOES-R Improvements in Solar and Space Weather Observations



Solar Imaging Spectral Range Wavelength Bands Imaging Frequency	Solar X-ray Imager 0.6 to 6 nm 9 60 sec/image	Solar UltraViolet Imager 0.9 to 32 nm 6 20 sec/image
Solar X-Ray flux (XRS)	2 bands from 0.05 to 0.8 nm	Same
Solar Extreme UV flux (EUV)	5 bands from 5 to 127 nm	Reconstructed full spectrum in 5-127 nm range from 3 bands and model
Energetic Particles	Protons: 0.8 - >500MeV in 7 log intervals, Alpha particles: 3.8-400MeV in 6 log intervals, Magnetospheric protons: 80keV-800keV, Electrons: 30keV-400MeV in 8 channels	Protons: 30ev - 30keV in 15 log intervals, Magnetospheric protons: 30 eV-4MeV, Electrons: 30keV-400MeV in 11 channels
Magnetometer	±1000 nT with 0.03nT	±1000 nT with 0.016nT
Space Weather Data Rate	~100 kbps	3.6 Mbps

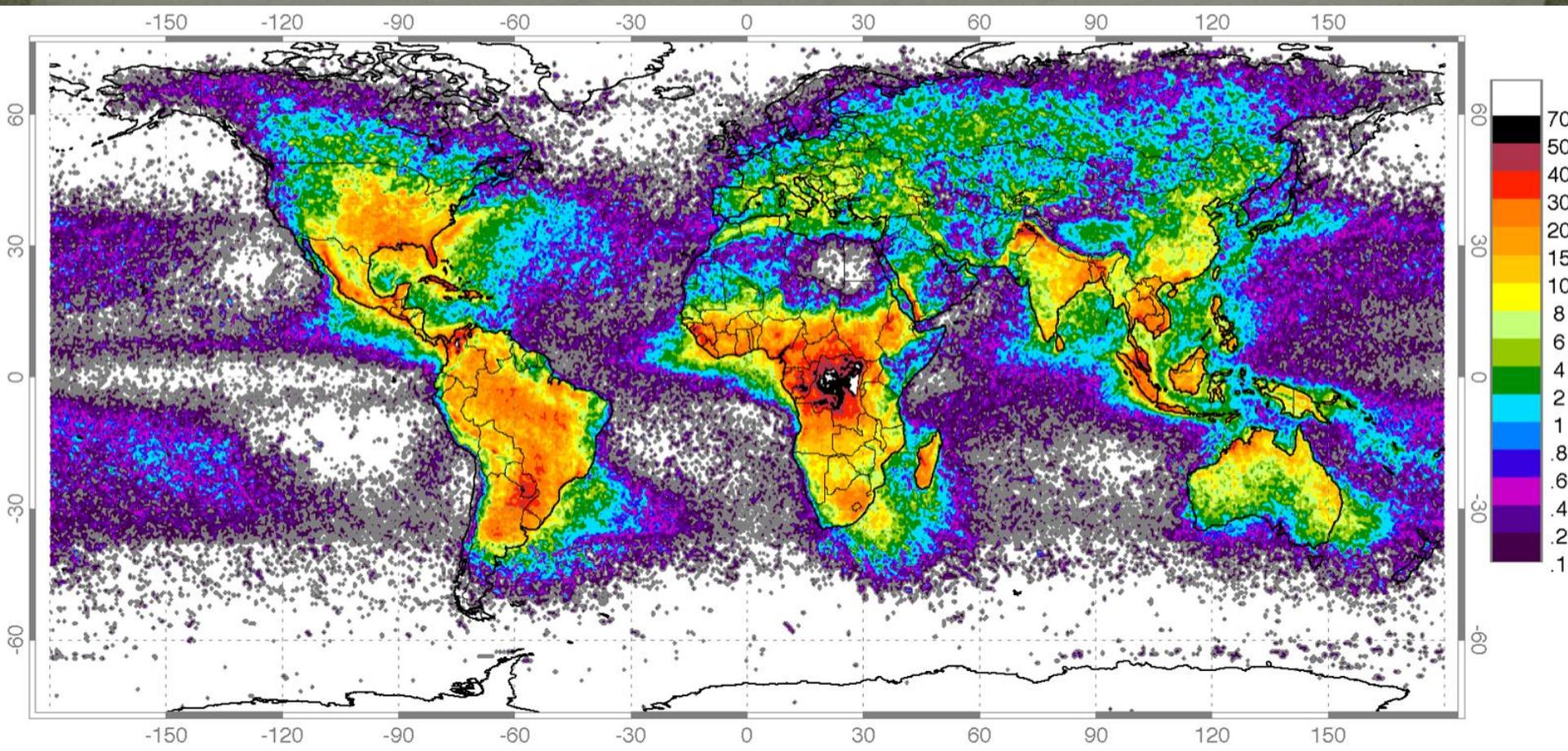


ABI has improved spatial, spectral and temporal coverage over earlier imagers.





High Resolution Full Climatology Annual Flash Rate



Global distribution of lightning from a combined nine years of observations of the NASA OTD (4/95-3/00) and LIS (1/98-12/04) instruments



GLM Mission Objectives

GOES-R GLM Mission Objectives

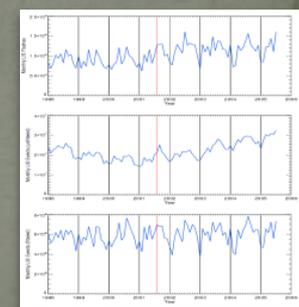
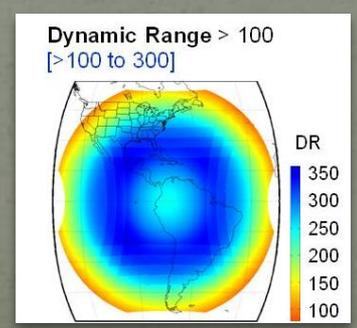
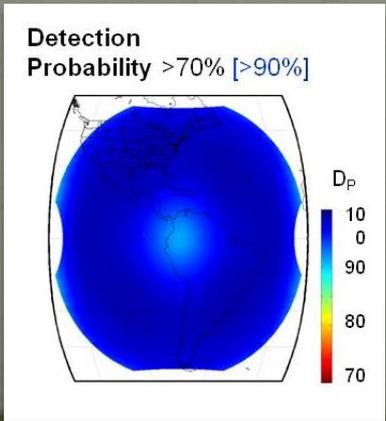
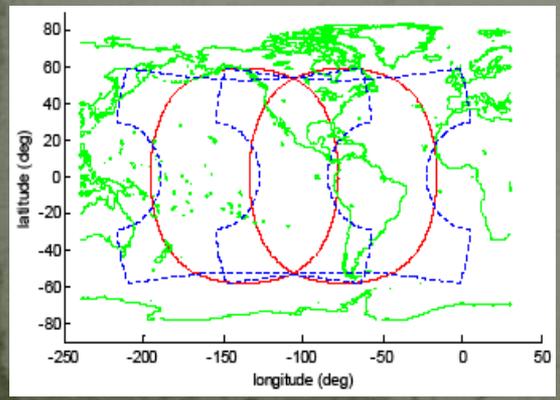
- Provide continuous full-disk lightning measurements for storm warning and nowcasting
- Provide sufficient temporal resolution to allow tracking of each lightning flash within a specific storm cell and calculation of its optical center over time
- Provide longer warnings of tornadic activity
- Accumulate a long-term database to track decadal changes in lightning activity

“Overarching Requirement”

- Post-processing data product to capture 70% of the lightning flashes
- False alarm rate less than 5%



Provide continuous Full-Disk lightning measurements	Provide longer warnings of tornadic activity		Accumulate decadal lightning data
	False Alarm Probability <5%	Detection Probability >70%	



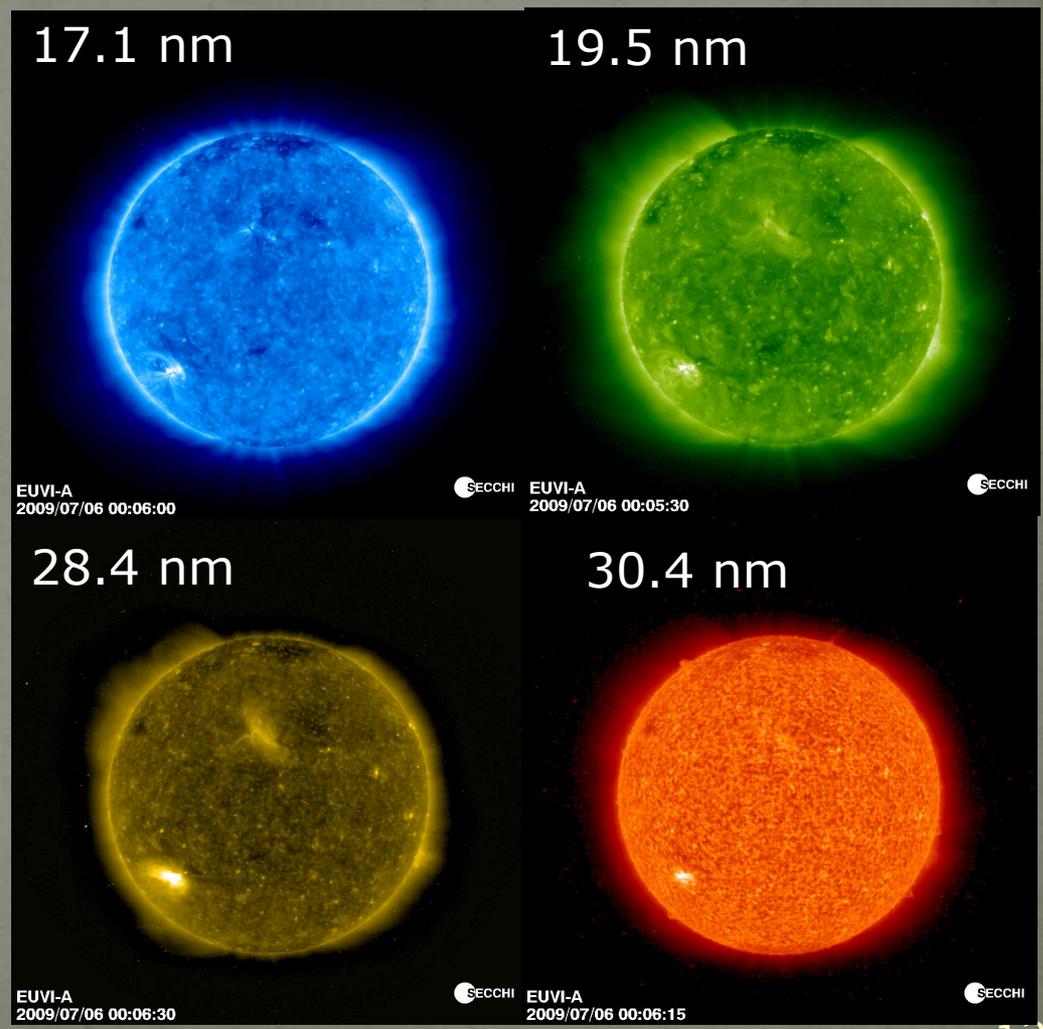


Improvements in Solar Observations



SUVI will provide better discrimination of temperature and density at higher spatial resolution compared to SXI

4 of the 6 SUVI bands are similar to those on STEREO SECCHI EUVI





Ground Segment FUNCTIONAL OVERVIEW



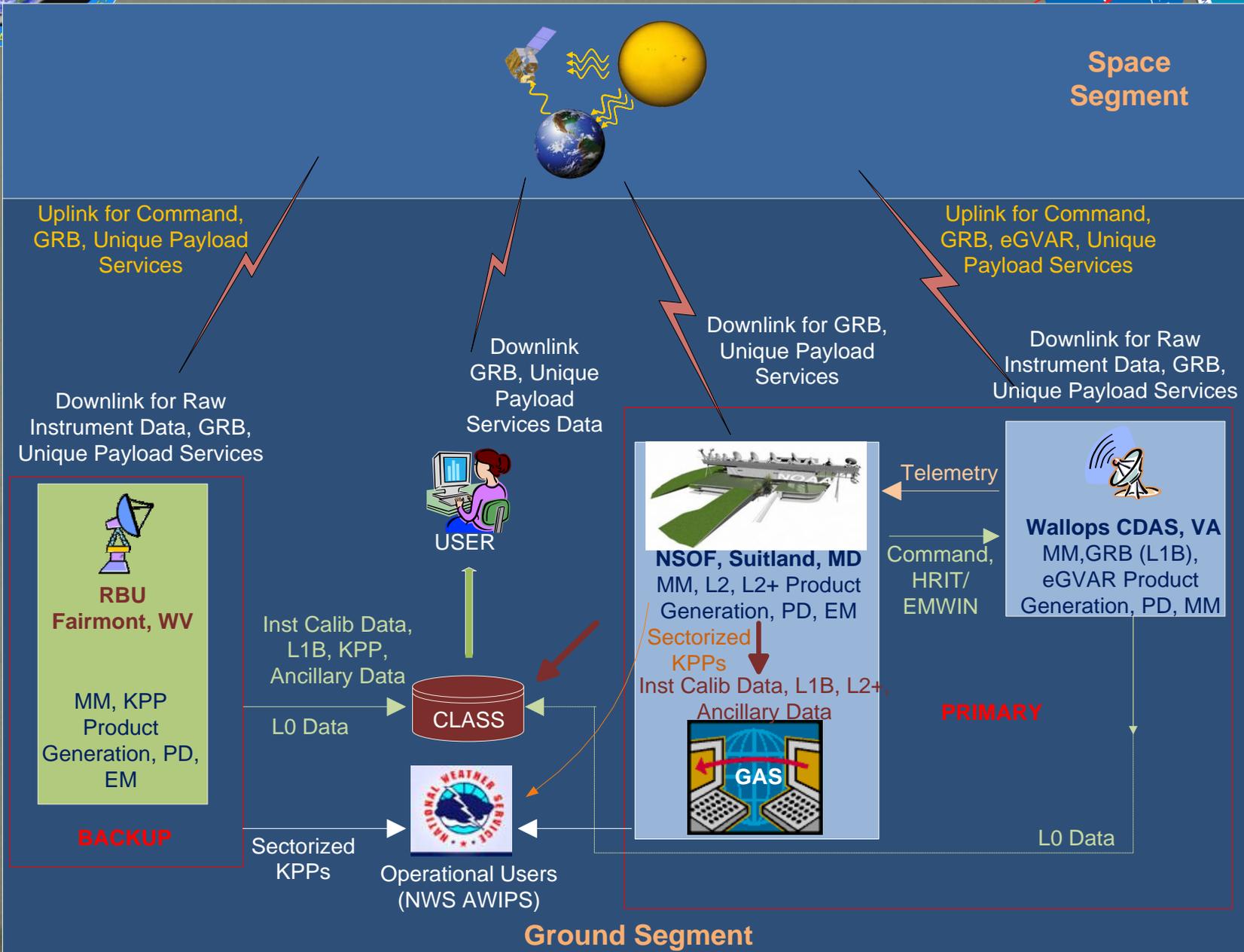
Ground Segment Contract

- Harris Corporation, Government Communications Systems Division (GCSD), Melbourne, FL was selected as the Ground Segment core (prime) contractor on May 27, 2009
- Development of Core Ground Segment
 - Mission Management
 - Enterprise Management
 - Product Generation
 - Product Distribution
 - Internal (i.e., intra-site) telecommunications
- Total Ground Segment integration and checkout
 - Integration of affiliated Ground Segment developments, including GAS and antennas
 - Interfaces to external systems, including CLASS and ADRS
- Transition to NOAA Operations





GOES-R Notional Architecture





Mission Management



- Functionality
 - Space-Ground communications (uplink/downlink receive & monitor), including antenna and front-end equipment
 - TLM & CMD
 - Unique Payload Services (LRIT, EMWIN, DCS, SARSAT)
 - GOES Rebroadcast (GRB)
 - Command generation and telemetry data processing
 - Raw (instrument) data processing
 - Mission scheduling and planning
 - Orbit & Attitude determination and maneuver planning
 - Product Monitor
 - Image Navigation and Registration (INR) monitoring
 - Routine instrument calibration support
 - Instrument raw data temporary storage
 - Telemetry data archive, engineering analysis system, and remote access to telemetry
 - Integrate
 - Flight Software (FSW) management
 - Simulators
 - Provide status messages to Enterprise Management



Product Generation



- Functionality
 - Process Level 0 data to calibrated and navigated products (Level 1b)
 - Monitor Radiometric and Image Navigation & Registration Performance
 - Assemble GOES-R Rebroadcast data set and send to MM for uplink
 - Assemble Emulated GVAR (eGVAR) data sets and send to GOES-N interface
 - Receive ancillary data files
 - Process Level 1b data to Level 2 and higher-order products
 - Send Level 1b and Level 2+ products to PD
 - Maintain calibration database
 - Provide status messages to Enterprise Management



GOES-R Product List



Aerosol Detection (incl Smoke & Dust)	Clear Sky Masks	Upward Longwave Radiation: Surface
Suspended Matter / Optical Depth	Radiances*	Upward Longwave Radiation: TOA
Volcanic Ash: Detection & Height	Downward Solar Insolation: Surface	Ozone Total
Cloud & Moisture Imagery (KPP)	Reflected Solar Insolation: TOA	SO2 Detection
Cloud Optical Depth	Derived Motion Winds	Flood / Standing Water
Cloud Particle Size Distribution	Fire / Hot Spot Characterization	Ice Cover / Landlocked: Hemispheric
Cloud Top Phase	Land Surface (Skin) Temperature	Snow Depth
Cloud Top Height	Snow Cover	Surface Albedo
Cloud Top Pressure	Sea Surface Temperature	Surface Emissivity
Cloud Top Temperature	Energetic Heavy Ions*	Vegetation Fraction: Green
Hurricane Intensity	Magnetospheric Electrons and Protons: Low Energy*	Vegetation Index
Lightning Detection: Events & Flashes*	Magnetospheric Electrons and Protons: Medium & High Energy*	Currents
Rainfall Rate / QPE	Solar and Galactic Protons*	Currents: Offshore
Legacy Vertical Moisture Profile	Geomagnetic Field*	Sea and Lake Ice: Age
Legacy Vertical Temperature Profile	Solar Flux: EUV*	Sea and Lake Ice: Concentration
Derived Stability Indices	Solar Flux: X-Ray*	Sea and Lake Ice: Extent
Total Precipitable Water	Solar Imagery: UV*	Sea and Lake Ice: Motion
Aerosol Particle Size	Cloud Type	Probability of Rainfall
Aircraft Icing Threat	Convective Initiation	Rainfall Potential
Cloud Ice Water Path	Enhanced "V"/ Overshooting Top Detection	Total Water Content
Cloud Imagery: Coastal	Low cloud and Fog	Absorbed Shortwave Radiation: Surface
Cloud Layers / Heights & Thickness	Turbulence	Downward Longwave Radiation: Surface
Cloud Liquid Water	Visibility	
ABI	GLM	SEISS
Magnetometer	EXIS	SUVI
	OPTIONAL PRODUCTS	* GRB



Product Performance Responsibilities



- GS Contractor
 - Implement algorithms such that products meet **all** product performance parameters
 - Meet product refresh rate requirements
 - Meet vendor-allocated ground latency requirements
 - Meet Product Measurement Precision requirements
- Instrument Vendor
 - Develop Lib (and GLM) algorithms
 - In conjunction with the GS contractor, responsible for meeting Mapping Accuracy requirements
 - In conjunction with AWG, responsible for meeting
 - Product geographic coverage/conditions
 - Product vertical resolution
 - Product horizontal resolution
 - Product measurement range
 - Product measurement accuracy
- AWG
 - Develop L2+ algorithms such that products meet parameters described above
 - Provide IV&V for Lib algorithms



Product Distribution



- Functionality
 - Distribute GRB to Mission Management for RF Transmission
 - Distribute data and products (L1b/L2+) from PG to operational users
 - Translate products into appropriate formats
 - Provide a user access point for products
 - Temporary store products for User Access
 - Distribute selected data, products (Lo, L1b, L2+), ancillary data, algorithms, and associated metadata to CLASS for long-term archive
 - Distribute emulated GOES Variable Format (eGVAR) to GOES-N ground segment for RF transmission through GOES-N series satellites
 - Provide status messages to Enterprise Management



Enterprise Management



- Functionality
 - Enterprise Management is the overarching function that monitors and reports status on the entire GS
 - All GS elements (hardware and software)
 - Networks
 - Communication links and antenna operations
 - Provide real time textual and graphical display of system performance and status
 - Supervise primary and backup site functions, and the interfaces to external systems
 - Provide incident tracking and status
 - Supervise enterprise IT security



More info at:

<http://www.goes-r.gov/>

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